

## Case Study: Cover Cropping in the Custard Apple Inter Row, New South Wales Northern Rivers, 2021-22

Dr Abigail Makim, Dr Christopher Carr, Dr Alana Govender, Mr Richard Llewellyn and Professor Terry Rose

### ***Farm snapshot***

Orchard age: 45 years  
Row spacing: various 12m, 7m  
Varieties: African Pride, KJ Pinks  
Total number of trees: 850, various ages  
Location: Alstonville  
Soil type: red krasnozem

### ***A bit more about the growers***

Wendy and John have been growing custard apples for 30 years. They manage an IPDM, low chemical system, with a focus on taking care of their biocontrols and other beneficial invertebrates, including pollinators.

Good cover on the orchard floor has been a longstanding priority for Wendy and John. When they bought this orchard, they took on what they describe as a “ground-zero” inter row, where herbicide use had previously been very heavy. Over the past 30 years they had intermittently seeded the inter row with low growing ground cover species including clovers and grasses. They have also developed a 100% living ground cover under the trees program, managed without herbicides.

### ***Goals for the inter row cover crop trial***

- Pollination – can improved vegetative diversity in the inter row support more pollinators suitable for the crop? Will this improve fruit set, particularly second fruit set?
- Soil health – can a bulk-forming cover crop add organic matter and increase soil stabilisation in the inter row?

### ***Potential challenges associated with inter row cover cropping in the custard apple orchard inter row***

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Fungal pathogens:

- Will there be changes to air flow & humidity in the inter row linked to a cover crop?
- Will this increase the risk of fungal disease for the crop?



*Photo 1: April 2022, 7 months into the trial. For Wendy, 2022 delivered a record in terms of “very clean fruit” - despite the many challenges of the year’s flood season.*

This document has been prepared in consultation with Wendy and John Graham, for the purposes of sharing their experience with the wider custard apple industry.

### ***Cover crop strategy***

This trial employs a general strategy of increasing ecological complexity and biodiversity in time and space on-farm in order to secure a range of ecosystem services for pollination, soil health and pest regulation.<sup>1</sup> Specifically, the trial will increase plant species diversity in the inter row throughout the orchard for an entire season.

There are two inter row seeding dates using alternate rows, 6 weeks apart, to prolong the cover crop species mix flowering period across the season. The objective is to keep pollinators active and in the orchard into January, when second flowering takes place.

This strategy also compliments the existing management practice of using alternate rows for picking. Seed strips are 1.2m wide down the centre of the inter row. Standard mowing and brush cutting under the trees will be ongoing.

### Seed mix recommendation

The seed mix recommendation provided for this trial (below) is based on a review of a number of key considerations for custard apple orchards.

#### *Pollinators*

There is limited information available upon which to base a recommendation for a seed mix of cover crop annuals with benefits for custard apple-specific pollinators in Australian orchards.<sup>2-4</sup>

The recommended seed mix (below) is balanced across a number of different plant families to ensure an increase in bulk flowering and sequencing of flowering in the inter row over many months.<sup>5</sup> Species are selected to provide a range of days to maturity and bulk flowering – for example, buckwheat is typically quick and prolific, while sunflowers are slower and can sustain many beneficial insect species with their large flowers later in the season. Sequencing is further enhanced with the implementation of two different seeding dates, 6 weeks apart.

The diversity of flower types in the mix will resource a diverse range of invertebrate species, some of which may be potential pollinators.<sup>6</sup> The seed mix selected for this trial is weighted towards higher *pollen* floral resources (especially summer grains and Asteraceae) to encourage and retain abundant and diverse crop-appropriate pollinators in the orchard, including various beetles (Nitidulidae).<sup>4</sup> Note that this differs from standard commercial “pollinator seed mixes”, which focus on high percentages of the

*nectar* producing plant species especially favoured by honey bees – honey bees do not pollinate custard apples.



*Photo group 2: Beneficial insects including hover flies are especially attracted to buckwheat flowers. Buckwheat is included in this trial’s seed mix.*

The mix will also produce bulk, which can provide shelter and stable habitat for invertebrates in the inter row throughout the day, allowing for repeated local pollinator visits as custard apple flowers transition from male to female.

Finally, anecdotal information indicates that some growers believe that various small insects, including vinegar flies, which are attracted to decomposing organic matter, may also pollinate.

#### *Soil health*

There are numerous well understood benefits for soil health associated with the recommended seed mix.<sup>7</sup> As a bare minimum it will improve ground cover and prevent soil loss. It can greatly

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increase the production of bulk organic matter on-farm for incorporation into mulching and composting. Diverse living roots in the soil year-round can also add a number of soil health benefits including mitigation of compaction, stabilisation of aggregates, and more.<sup>8</sup>

#### *Pest regulation*

While there is a particular focus in this trial on using the cover crop to resource pollinators and provide bulk for soil health, there is also good evidence that cover crops will benefit generalist predators and parasitoids, which can help to suppress pests of the crop.<sup>9</sup>

#### *Screening the seed mix for risks, practicality & value*

Species suitable for the seed mix were drawn from standard commercial options currently available as cover crops. They were also screened against:

- **Pest reservoir.** A number of commonly recommended cover crop species can host Green Vegetable Bug, which is a pest of many crops, though not currently custard apples. The idea is to avoid a potential build up in the orchard of a potentially problematic insect. It is recommended that large pod forming brassicas and legumes are

kept to under 15% total of the seed mix.

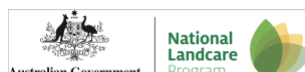
- **Weediness.** Brassicas in particular, can set a lot of seed, with a potential future risk for weediness. For this reason, brassicas are recommended at a rate of not more than 5% total of the seed mix.
- **Suitability and practicality for standard inter row management.** For example, sunn hemp was not included for this farm because it can become woody and grow to well over 2m for many months. Given available machinery and also possible fungal risk, this was excluded from the mix.
- **Market availability.**
- **Value for money.**

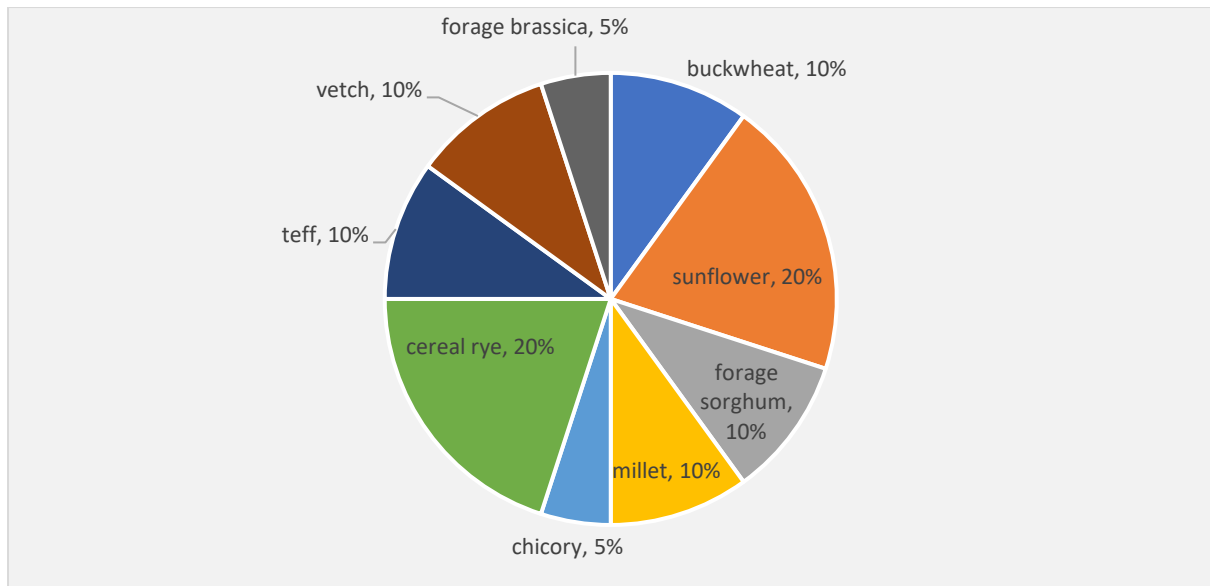
#### *Irrigation*

No additional irrigation was available in the inter row for the trial. The trial relied on an existing combination of drip and sprinkler already in place along the tree-line.

Irrigation was an important consideration during the set-up of the trial. The previous summer and been hot and dry, impacting yield in many crops in the area. A number of inter row cover crop trials on other farms had also struggled under these conditions.

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Seed mix, October 2021

### **Ground preparation & machinery**

In the lead up to this trial, this orchard inter row was mowed as per standard practice with a zero-turn 72” deck plate mower. Ground cover under the trees was managed with a brush-cutter. The inter row was also grazed by a small herd of cattle in early spring.

For the purposes of this trial, an aerator/spiker was run along the centre strip where the seeding was to take place.

There was no additional ground preparation, including no seed-bed preparation. This is the exception rather than the rule, at least for the first year of inter row seeding. Many other orchards will have compacted soil and will likely benefit from light seed-bed preparation with a rotary hoe, flail mower or similar.

Seeding was done with a Network Seeder - linkage drawn, direct drill, double disc, open roller, single box, 1.4m wide.



Photo 3: The Network Seeder is 1.4m wide. For this trial the centre strips were seeded at 1.2m.

The trial was designed to be achievable with existing machinery and the growers’ preferred inter row management practices in place for the life of the trial.

The Network Seeder was made available free of charge by BioResEd for trials for growers located in the NSW northern rivers, Gympie and Bundaberg regions.

### **Timeline**

*October 2021* – A centre strip of the cover crop seed mix is seeded at 1.2m wide in both the 7m and 12m inter rows. It is decided that 1.2m is the most suitable width, balancing the benefits of having a cover crop in place while retaining clear

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areas for airflow, access, maintenance and so on.

*November 2021* – The second alternate row seeding took place 6 weeks after the first seeding.

An entomology survey was done on the day of the second seeding to examine the invertebrates present in the orchard during a farm walk, using observational methods. It was noted that there was high species diversity in the pre-seeding vegetation in the orchard, including pollinators such as *Lauxaniid* flies and parasitoid wasps.



*Photo 4: November 2021, Lauxaniid fly on a dandelion flower.*



*Photo 5: November 2021, wasp (family Diapriidae) parasitising a fly on a custard apple tree leaf.*

*December 2021* – There was excellent early establishment and bulk flowering of buckwheat. Buckwheat is noted to be very attractive to important beneficial invertebrates including potential pollinators, parasitoid wasps and generalist predators including hover flies and lady beetles. This provided a strong start for this inter row trial. The species mix grew well in conjunction with pre-existing prairie grass and clovers (Photo 4).

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Photo 6: December 2021, buckwheat and forage brassica have established well in the 12m inter row.

During this period, the width of the centre cover crop strip in the 7m rows was reduced to ensure hygiene and general access (Photo 7). This produced good bulk, which was delivered to the centre (not under the trees), while buckwheat centre strips were retained.

It should be noted that mowing with buckwheat strips also created mulch that is good for fly (Diptera) larvae reproduction. Some fly species such *Megaselia* spp. (Phoridae) have been reported as pollinators and were present in the November farm entomology observations.



Photo 7: December 2021, mowing with buckwheat strips retained but a reduced width of the centre strip in 7m inter row.

January 2022 – As cover crop species matured, there was an increase in the abundance and diversity of floral resources and also general bulk production in the inter row. There was strong performance from forage sorghum, sunflower, cow pea & chicory.

With alternate row seeding and by selecting a diverse range of species for the seed mix, we achieved a sequencing of flowering through time and throughout the orchard. This helped to provision beneficial insects in the orchard, keeping them there in the lead up to when they will be needed most – second tree flowering and fruiting.

It is quite common to have varied results, row-by-row, in terms of total species mix establishment (Photos 8, 9 & 10). This is because calibrating seeders for seed mixes is difficult when there are various seed sizes involved – the result being an uneven distribution of the mix. When considered

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at the level of a hectare, rather than square metre, this uneven result is however satisfactory in terms of the benefits the seeding generates for the orchard as a whole.

There was very careful ongoing maintenance of living ground cover under the trees during this period to ensure good growth and good air flow to avoid a build-up of humidity, as linked to fungal pathogens (Photos 8 & 10).



*Photo 8: January 2022, forage sorghum and cow pea were included in the second alternate row seeding.*



*Photo 9: January 2022, chicory, forage sorghum.*



*Photo 10: January 2022, prior to the commencement of the flood season.*

*February 2022* – There has been care and attention invested in sustaining the cover crop centre strips, while at the same time, also maintaining regular mowing next to young trees.

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*Photo 11: February 2022, cover crop centre strips and mowed strips*

*March 2022* - Self-seeded forage sorghum has prolonged the life of the cover crop strip for many months without any additional time, effort or money spent on re-seeding.

Wendy observed her orchard to be very productive and resilient. There was good management of soil and water flow in the orchard throughout the 2022 flood season, and this can be partially attributed to the cover crop.

The centre strips were mowed back completely 4 weeks prior to harvest. This was to ensure no disturbance or damage to fruit from machinery, mulch particles, disrupted fungal spores and so on.



*Photo 12: March 2022, midway through the flood season.*

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### *The experience of others*

The experiences of this trial were shared directly with other growers and industry in the area. On the day of inter row seeding at Wendy and John's, there was a demonstration session.

The seed mix, above, was also shared, and utilised subject to availability from suppliers. A number of species substitutions were made, which is quite usual.

This farm, below (Photos 13 & 14), has achieved excellent establishment with

sunn hemp, cow pea, teff and sorghum. There is plenty of space and light to the orchard floor for a centre strip. Under the trees is maintained with conventional practices. The strips have been planted in alternate rows for optimal access during harvest.

This grower observed good management of soil and water flow in the orchard throughout the 2022 flood season, and attributes this in part to the cover crop.



*Photo 13: March 2022, Sunn hemp and cow pea are especially strong in this inter row.*

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Photo 14: March 2022, a good result for forage sorghum in this inter row.

### ***Results and discussion***

This trial occurred during the 2022 flood season in northern NSW, with unprecedented severe wet weather - upwards of 2.5m rain on this farm to 9th June 2022.

The single most important result for this cover crop trial was robust and sustained stabilisation of the sloping orchard floor during a prolonged period of very substantial water movement. In this connection, the inter row seed mix was able to guarantee a contribution to pollination, soil health and pest regulation. When we compare the orchard floor in January 2022 (Photo 8) with March 2022 (Photo 10), we can see that not only is the orchard floor undamaged, but it continues to sustain thriving ground cover and diverse vegetation species, despite difficult conditions.

The establishment and longevity of the cover crop was comparatively strong for a first seeding, indicating good basic soil health in this orchard inter row.

The growth of the cover crop in terms of bulk and longevity exceeded expectations relative to many other trials. What was different here was very good soil health in the inter row from the outset and substantial record-breaking precipitation.

In a flood season, this result was beneficial for the buffer it afforded the orchard; for its capacity to absorb the volume of water moving through the landscape.

### ***Pollination, especially second fruit set***

The impact of the wet season was so substantial as a confounding factor that it was not possible to assess impacts on pollination. Furthermore, these conditions generated multiple stressors for the orchard. Yield for this season is reported to be somewhat down on the previous year. In terms of pollination, it is reasonable to speculate that, amongst these stressors, the sustained daily wet conditions may have adversely impacted the capacity for nitidulid pollination.<sup>2</sup>

### ***Pest regulation***

While yield was down on previous years, the crop was noted to be “very clean”.

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Wendy reported that biocontrols were observably active; there was no scale and mealy bugs were quickly consumed by lady beetles. In past years it has been standard practice to put out a second release of biocontrols; this was not necessary in 2022.

#### *Conservation biological control*

As Wendy and John have worked over the years to reduce chemical inputs and supplement beneficial insects to control pests and enhance pollination, it was anticipated that a diversity of insects would be present. However, in the pre-trial insect survey in November 2021, field observations indicated an especially high diversity of insects from a wide range of insect orders. This was relatively unique when compared to other surrounding orchards (mainly macadamia).

Conservation biological control is largely based on the idea that increased biodiversity will lead to more stable systems in which there will be less likelihood of pest outbreaks.<sup>10</sup> This is a longer-term approach to pest control and takes several years to build capacity in the system. It was evident from the surveys that vegetative diversity and the absence of pesticides have allowed for a range of insect species to thrive from many different insect orders. This is important as each insect species has slightly different ecological needs and occupies particular niche spaces. The more niche spaces available, the greater the diversity of insects.

Of note in this orchard were a wide range of parasitoid wasps from the families *Diapriidae*, *Braconidae*, *Ichneumonidae*, *Eulophidae* and *Chalcididae* families. A rich fly diversity included species from *Tipulidae*, *Chironomidae*, *Drosophilidae*, *Asilidae*, *Lauxaniidae*, *Phoridae* and *Syrphidae* (hoverflies), many of which have been found to visit flowers for either

pollen or nectar, which in turn has the potential to pollinate flowers.

There was also a wide range of spider species present in the orchard, which are important generalist predators. Spiders are greatly affected by pesticides and are a good indicator of orchard biodiversity based on size and number of different micro-habitats that they are found (e.g. rolled up in leaves, webs and ambush predators such as wolf spiders roaming the orchard floor).

Overall, the cover crop plantings will have enhanced the biodiversity on this already biodiversity rich orchard, maybe enhancing the “clean” fruit results in conjunction with the released bio-controls. Timing and cover crop species selection as well as tweaking conservation biological control enhancements could improve fruit-set. This will require some experimentation over time depending on season.

#### *Soils*

In addition to the preservation of inter row soil during a season where many neighboring orchards experienced erosion, the sustained success of this inter row cover crop indicates very good soil health as a baseline for this trial orchard.

This is atypical – many orchards have severely compacted and depleted soils in the inter row and the first 3 years of inter row cover cropping must be directed towards correcting this for the benefit of the orchard overall.

#### *Management practices*

The success of the cover crop created an unexpected management burden: in order for the rate of growth, its height and the amount of bulk it generated to be accommodated in the working inter row, additional mowing, innovation to mowing

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techniques and deployment of some new machinery operations were necessary.

The main adaptations, both implemented and/or to be considered for the future include:

- Ad hoc reduction of the width of the cover crop strip in the 7m rows, when growth was especially vigorous or access to the orchard was necessary.
- Planning to change to a 60” deck for the zero-turn mower, when the time comes to buy a new machine.

- In future years there will be increased skirting of trees to allow better access for machinery under trees plus the incorporation of cover crops and their maintenance.

#### *Next steps*

- Develop and trial more seed mixes, by farm, by season.
- Ongoing review of benefits, risks, management changes.
- Target and review inter row vegetation for pollination benefits.

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